International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.7718/Y.1709

(07/2010)

SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Data over Transport – Generic aspects – Transport network control aspects

SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS

Internet protocol aspects – Operation, administration and maintenance

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Framework for ASON management

Recommendation ITU-T G.7718/Y.1709

ITU-T

ITU-T G-SERIES RECOMMENDATIONS

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Recommendation ITU-T G.7718/Y.1709

Framework for ASON management

Summary

Recommendation ITU-T G.7718/Y.1709 contains the framework for ASON management. It places ASON management within the TMN context and specifies how the TMN principles may be applied. A management view of the ASON control plane is developed. This view provides the bases for the ASON management requirements specified in this Recommendation. Identifier spaces needed in ASON management are specified. Examples of management system structures and ASON related management applications are contained in the appendices.

The 2010 version of this Recommendation adds the requirements to support permanent connection to soft permanent connection migration, configuration of routing controller adjacencies, call detail record for accounting management, and refresh of management plane and control plane views.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T G.7718/Y.1709	2005-02-13	15
2.0	ITU-T G.7718/Y.1709	2010-07-29	15

FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

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In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

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1 Scope

This Recommendation addresses the management aspects of the ASON control plane and the interactions between the management plane and the ASON control plane. This Recommendation follows the TMN principles specified in [ITU-T M.3010] and the ASON architecture principles specified in [ITU-T G.8080]. Included are:

1) identification of reference points and interfaces between the management plane and the control plane;
2) a description of the larger context of ASON network and service management;
3) requirements for the:
   - use of ASON constructs, e.g., routing areas, SNPP links, etc.;
   - management of calls and connections;
   - configuration, fault, performance, accounting and security management for ASON.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T G.784] Recommendation ITU-T G.784 (2008), *Management aspects of synchronous digital hierarchy (SDH) transport network elements*.

[ITU-T G.805] Recommendation ITU-T G.805 (2000), *Generic functional architecture of transport networks*.

[ITU-T G.806] Recommendation ITU-T G.806 (2009), *Characteristics of transport equipment – Description methodology and generic functionality*.

[ITU-T G.874] Recommendation ITU-T G.874 (2010), *Management aspects of optical transport network elements*.

[ITU-T G.7710] Recommendation ITU-T G.7710/Y.1701 (2007), *Common equipment management function requirements*.

[ITU-T G.7712] Recommendation ITU-T G.7712/Y.1703 (2008), *Architecture and specification of data communication network*.

[ITU-T G.7713] Recommendation ITU-T G.7713/Y.1704 (2009), *Distributed call and connection management (DCM)*.

[ITU-T G.7713.1] Recommendation ITU-T G.7713.1/Y.1704.1 (2003), *Distributed call and connection management (DCM) based on PNNI*.

[ITU-T G.7713.2] Recommendation ITU-T G.7713.2/Y.1704.2 (2003), *Distributed call and connection management: Signalling mechanism using GMPLS RSVP-TE.*

[ITU-T G.7713.3] Recommendation ITU-T G.7713.3/Y.1704.3 (2003), *Distributed call and connection management: Signalling mechanism using GMPLS CR-LDP*.

[ITU-T G.7715] Recommendation ITU-T G.7715/Y.1706 (2002), *Architecture and requirements for routing in the automatically switched optical networks*, plus Amendment 1 (2007).

[ITU-T G.7715.1] Recommendation ITU-T G.7715.1/Y.1706.1 (2004), *ASON routing architecture and requirements for link state protocols*.

[ITU-T G.8080] Recommendation ITU-T G.8080/Y.1304 (2006), *Architecture for the automatically switched optical network (ASON)*, plus Amendment 1 (2008).

[ITU-T M.3010] Recommendation ITU-T M.3010 (2000), *Principles for a telecommunications management network*, plus Amendment 1 (2003), and Amendment 2 (2005).

[ITU-T M.3020] Recommendation ITU-T M.3020 (2009), *Management interface specification methodology*.

[ITU-T M.3100] Recommendation ITU-T M.3100 (2005), *Generic network information model*.

[ITU-T M.3120] Recommendation ITU-T M.3120 (2001), *CORBA generic network and network element level information model*, plus Amendment 1 (2002), and Amendment 2 (2003).

[ITU-T X.700] Recommendation ITU-T X.700 (1992), *Management framework for Open Systems Interconnection (OSI) for CCITT applications*.

[ITU-T X.731] Recommendation ITU-T X.731 (1992) | ISO/IEC 10164-2:1993, *Information technology – Open Systems Interconnection – Systems management: State management function*.

3 Definitions

No new terms and definitions are defined in this Recommendation.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations:

ASON Automatically Switched Optical Network

CC Connection Controller

CF Control plane Function

COS Class of Service

CP Control plane

CTP Connection Termination Point

DA Discovery Agent

DCC Data Communications Channel

DCM Distributed Call and Connection Management

DCN Data Communications Network

EMF Equipment Management Function

EMS Element Management System

E-NNI External Network-Network-Interface

GOS	Grade of Service
I-NNI	Internal Network-Network-Interface
LAN	Local Area Network
LCAS	Link Capacity Adjustment Scheme
LRM	Link Resource Manager
MP	Management Plane
NCC	Network Call Controller
NE	Network Element
NEF	Network Element Function
NMS	Network Management System
NNI	Network-Network-Interface
OAM	Operation, Administration and Maintenance
OS	Operations System
OSF	Operations System Function
OTN	Optical Transport Network
PC	Protocol Controller
RA	Routing Area
RC	Routing Controller
SC	Switched Connection
SDH	Synchronous Digital Hierarchy
SMS	Service Management System
SNC	SubNetwork Connection
SNCP	SubNetwork Connection Protection
SNP	SubNetwork Point
SNPP	SubNetwork Point Pool
SPC	Soft Permanent Connection
SRG	Shared Risk Group
TAP	Termination and Adaptation Performer
TMN	Telecommunications Management Network
TP	Termination Point
TTP	Trail Termination Point
UML	Unified Modelling Language
UNI	User-Network-Interface
UNI-C	User-Network Interface – Client
UNI-N	User-Network-Interface – Network
UTRAD	Unified TMN Requirements, Analysis and Design

VCAT Virtual Concatenation

VCn Virtual Container of Level n

5 Conventions

None.

6 Context and background

This clause briefly relates the contents of this Recommendation to the fundamental Recommendations on the ASON architecture, transport network functional models, management principles, and interface specification methodology.

6.1 Relationship to management information modelling

Figure 1 describes the relationship between the scope of this Recommendation and the definition of management information models.

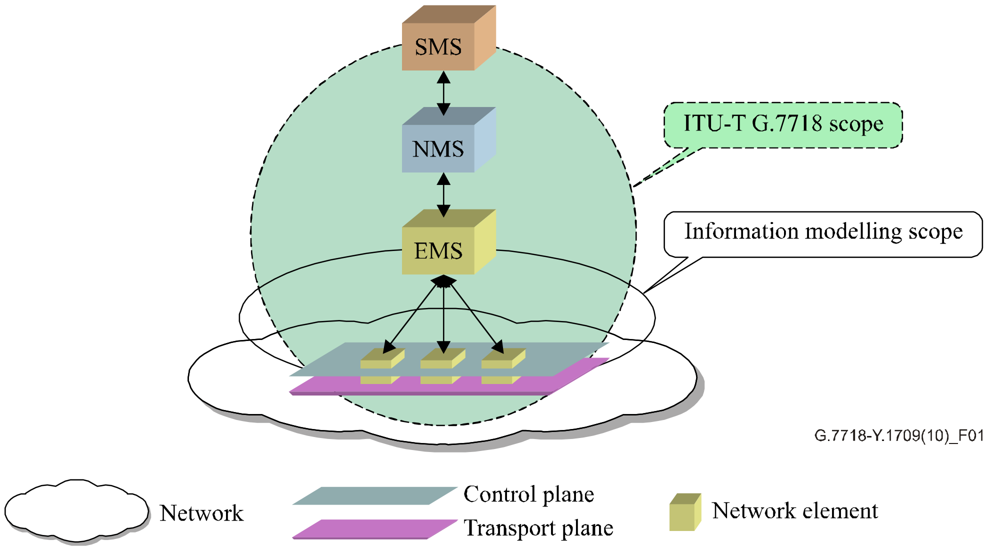


Figure 1 – Scope of ITU-T G.7718/Y.1709

6.2 Relationship to the ASON architecture

This Recommendation contains a management framework for ASON control planes, as specified in [ITU-T G.8080].

The ITU-T G.8080 reference architecture describes:

1) functional components of the control plane, including abstract interfaces and primitives;
2) interactions between call controller components;
3) interactions among components during connection set-up;
4) functional components that transform the abstract component interfaces into protocols on external interfaces.

The ITU-T G.8080 control plane functional components manipulate transport network resources in order to set up, maintain, and release calls and connections.

Generically, every ITU-T G.8080 control plane component has a set of special interfaces to allow for monitoring of the component operation, for dynamically setting policies, and for affecting internal behaviour. These interfaces are not mandatory and are provided on specific components only where necessary. Components are not assumed to be statically distributed.

6.3 Relationship to technology-specific Recommendations

The architectural specifications and functional requirements contained in [ITU-T G.8080] are applicable to connection-oriented circuit or packet transport networks, as defined in [ITU-T G.805].

6.4 Relationship to the TMN architecture

This Recommendation adheres to the TMN principles specified in [ITU-T M.3010].

[ITU-T M.3010] defines the logical layered architecture concept for organizing management functionality. The logical layers of interest in this Recommendation include the element management layer, the network management layer and the service management layer. As noted in [ITU-T M.3010], management objects defined for one layer may be used in others. Any management object may be used by any interface that requires it.

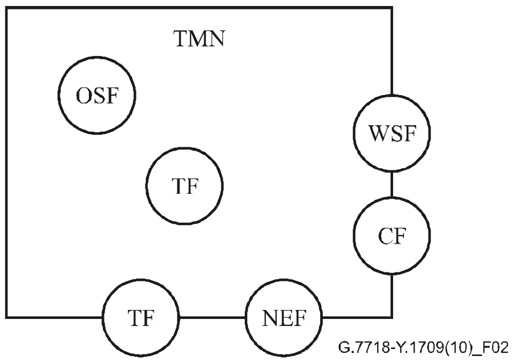
The element management layer is concerned with the information that is required to manage a network element (NE). This refers to the information required to manage the network element function (NEF), the control plane function (CF), and the physical aspects of an NE.

The network management layer is concerned with the information representing the network, both physically and logically. It is concerned with relationships among network elements, topographical connections, and configurations that provide and maintain end-to-end connectivity.

The service management layer is concerned with, and responsible for, the contractual aspects of services that are being provided to customers or available to potential new customers.

The layers of the logical layered architecture are used in this Recommendation to organize and to identify management requirements and management entities.

Figure 2 is based on Figure 2 of [ITU-T M.3010]. It illustrates the control plane function (CF), together with the traditional TMN function blocks. The CF represents the functions provided by the control plane components. It represents the functions within the control plane that permit the OSF to interact with and configure the control plane and permits the control plane to interact with the NEFs. It also supports the interaction between elements of the control plane itself. Additional information on interfaces is provided in clause 7.3.1 and in Figure 4.



CF Control plane function
NEF Network element function
OSF Operations systems function
TF Transformation function
WSF Workstation function

Figure 2 – Control plane function in TMN function blocks form

The CF block has been added to Figure 2 of [ITU-T M.3010] to emphasize the control plane functionality of interest in this Recommendation. In a more general setting, the CF function block can be considered to represent those functions not included in the NEF.

6.5 Management perspective

The management plane (MP) interacts with control plane (CP) components by operating on a suitable information model, which presents a management view of the underlying component resource. The objects of the information model are physically located with the represented CP component, and interact with that component via the monitor and configuration interfaces of that component. These interfaces should be collocated with the managed object and the control component. These interfaces are completely contained within equipment.

The intention of this Recommendation is to define general interactions between the MP and the CP independently of the distribution of the CP components. The distribution of the CP components, i.e., protocol controller (PC), network call controller (NCC), connection controller (CC), link resource manager (LRM), discovery agent (DA), routing controller (RC), and directory manager can range from centralized to fully distributed over network elements (NE), element management systems (EMS) and network management systems (NMS). This Recommendation places no constraints on the placement of CP components.

Table 1 shows the relationship between the TMN logical layer functions and the ASON components. This relationship is defined in terms of the view of the resource being managed. It should be noted that this Recommendation does not require that ASON control plane data be replicated in the management plane.

Management activities are divided into five broad management functional areas, as described in [ITU-T X.700]. These functional areas provide a framework through which the appropriate management services support a service provider's business processes. The five management functional areas are:

– performance management;
– fault management;
– configuration management;
– accounting management;
– security management.

Table 1 – ASON components and the TMN logical layers

ASON component	TMN logical layer function
Call controller	Service Management Layer – OS function Network management layer – OS function
Connection controller	Network management layer – OS function
Discovery agent	Element management layer – OS function Network management layer – OS function
Link resource manager	Network management layer – OS function
Protocol controller	Element management layer – OS function Network management layer – OS function
Routing controller	Network management layer – OS function
Termination and adaptation performer	Element management layer – OS function
Directory service	Element management layer – OS function Network management layer – OS function

6.6 Methodology

[ITU-T M.3020] describes the TMN interface specification methodology, *Unified TMN Requirements, Analysis and Design (UTRAD)*. This Recommendation contains the key artifacts for the requirements phase of UTRAD.

In this Recommendation, the ASON management requirements are documented in textual form.

The UTRAD analysis phase uses an object-oriented paradigm. The analysis phase identifies interacting entities, their properties, and the relationships among them. The artifacts from this phase consist of various UML static and dynamic diagrams and supporting text.

7 Architecture perspective

7.1 Fundamental elements

Figure 3 illustrates the relationships of interest to management among the fundamental elements of a network. The objective of this Recommendation is to provide the framework for the management of the ASON control plane within the total management context illustrated in Figure 3. Where appropriate, this Recommendation provides references to ITU-T Recommendations that address other aspects of the total management context.

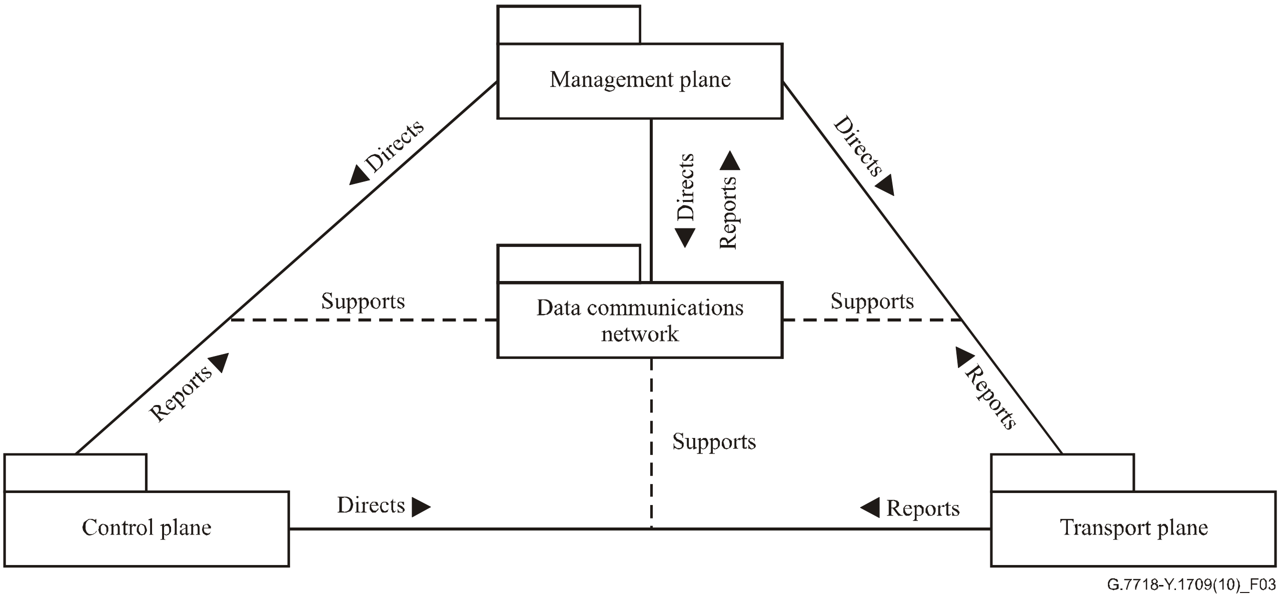


Figure 3 – Relationships among the fundamental elements

7.2 Reference points and interfaces

This clause summarizes the reference points and interfaces relevant to ASON management. These are listed in Table 2.

Table 2 – Summary of reference points and interfaces

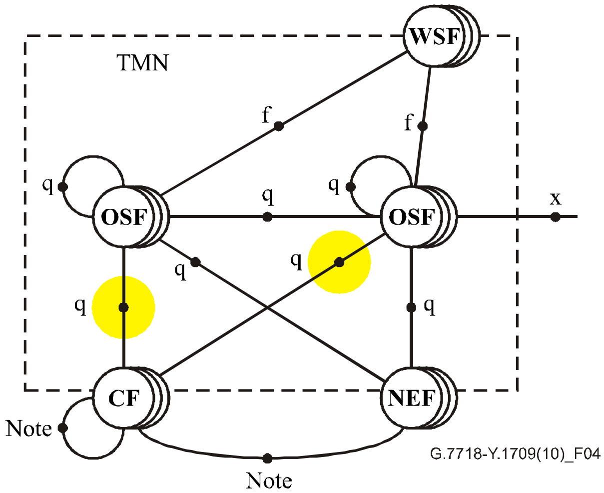
	ITU-T M.3010	ITU-T G.805	ITU-T G.806	ITU-T G.8080/Y.1304
Reference points	f, g, m, q, x	Connection point, access point, termination connection point	Management point	UNI, E-NNI, I-NNI
Interfaces	F, G, M, Q, X			UNI, E-NNI, I-NNI

7.3 Management reference points and interfaces

7.3.1 High level view of the q reference point

Figure 4 provides a high level view of the TMN reference points for ASON management.

The internal structure of the MP and of the CP does influence the use of the q reference point. Note that interfaces between ASON CFs are not within the scope of this Recommendation. Similarly, interfaces between the ASON CFs and the NEFs are not within the scope of this Recommendation.



NOTE – This reference point is not within the scope of ITU-T G.7718/Y.1709.
Highlighted reference points are within the scope of ITU-T G.7718/Y.1709.

Figure 4 – The TMN reference points for ASON management

7.3.2 Network element function with control plane functions

The equipment management function (EMF) provides the means through which a management system and other external entities interact with the network element function (NEF). Figure 5 illustrates the EMF elements within an NE. It must be noted that this illustration does not provide an exhaustive description of the functions that may be contained in an NEF. Figure 5 is based on Figure 5 of [ITU-T G.7710].

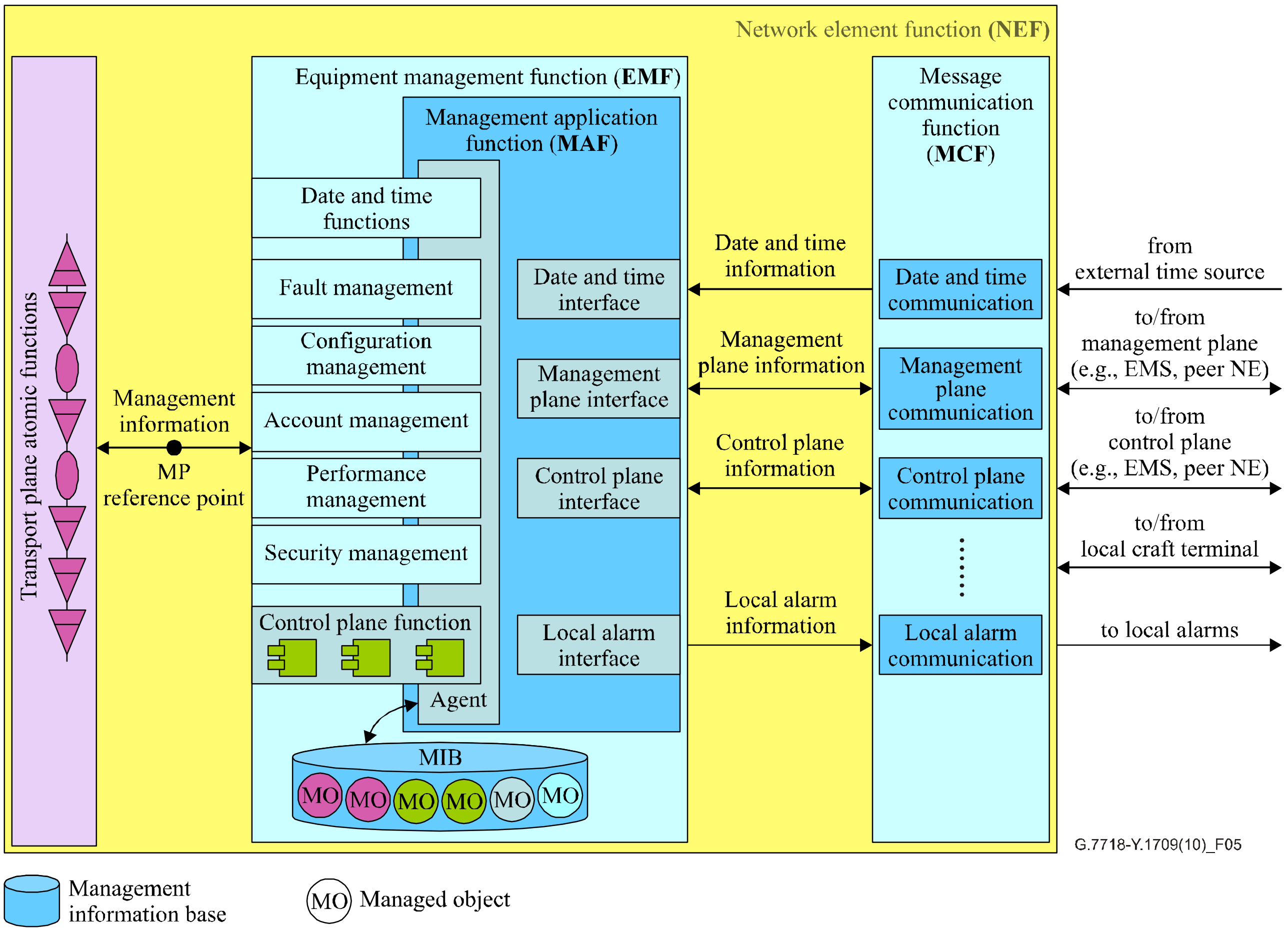


Figure 5 – The management view of the reference points and interface

In Figure 5, components of the control plane function include call control, connection control, routing control, link resource manager, discovery agent, and termination and adaptation performer.

See [ITU-T G.7710] for additional information on the external time reference, the management plane, and local alarms interfaces.

8 Requirements context

This clause introduces the ASON components and constructs that are used in clause 9 where the ASON management requirements are specified. Clause 8 is explanatory and non normative. It is intended to provide a management perspective on components and constructs. [ITU-T G.8080] should be consulted for definitions of the control plane components.

8.1 Control plane component relationships

Figure 6 shows the ASON components, as defined in [ITU-T G.8080].

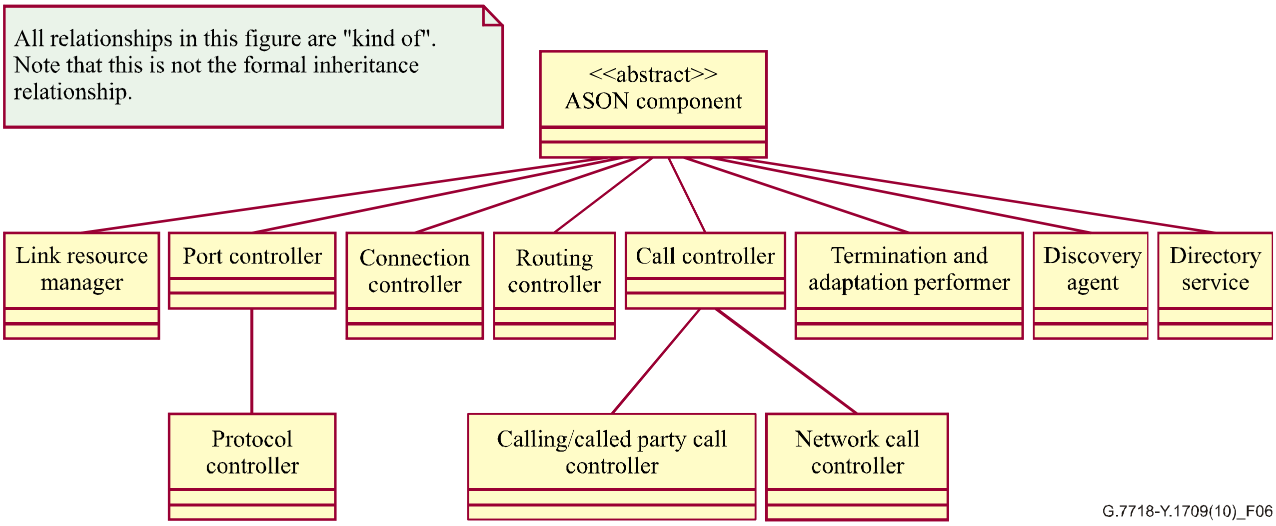


Figure 6 – ASON component relationships

The following management functions apply to the list of control plane components shown in Figure 6. Note that accounting management and security management requirements are for further study.

1) TAPs require fault management, configuration management, and performance management.
2) DAs require fault management, configuration management, and performance management.
3) LRMs require fault management, configuration management, and performance management.
4) NCCs require performance management including call statistics, e.g., number of call completed, number rejected, etc. NCCs also require fault management and configuration management.
5) RCs require fault management, configuration management, and performance management.
6) CCs require fault management, configuration management, and performance management.
7) Directory services require configuration management.

8.2 ASON control-related services

ASON control-related services are provided and consumed across service specific interfaces. ASON reference points collectively refer to a set of services. There is no requirement for co-located interfaces.

In this context, ASON control-related services do not refer to the services that a user can obtain from an ASON network. ASON control-related services refer to the services provided by individual ASON components via their external interfaces. (These are referred to as input interfaces in [ITU-T G.8080].) Defining these services is useful as many requirements discuss signalling, routing, etc., processes and the specification of ASON control-related services makes determining which components are affected by such requirements more obvious.

A candidate set of ASON control-related services is illustrated in Figure 7.

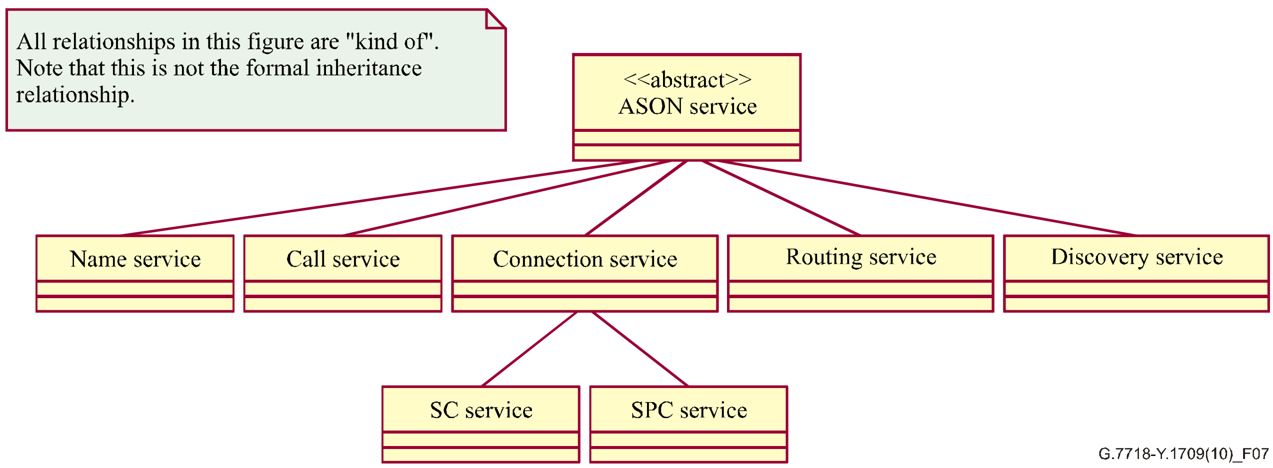


Figure 7 – ASON control-related services

ASON service objects have the following characteristics:

1) All ASON service objects must support operations to enable and disable the service.
2) The discovery service may be used to provide automatic topology configuration whether or not other ASON services are provided. The discovery service and protocol objects should therefore not rely on other ASON services.
3) ASON call service is mainly concerned with call admission control policies.
4) ASON connection service is mainly concerned with connection admission control.
5) All ASON protocol objects must support operations to enable and disable the protocol.

8.3 Domains

As described in [ITU-T G.8080], a domain represents, and is characterized by, a collection of entities that are grouped for a particular purpose. Consequently, there are different types of domains. Domains are established to implement operator policies and have a range of membership criteria. Domains are intrinsically linked to policies, as decisions about the services at the domain boundary are policy decisions. The policy is "what is required", and the policy results in an action on a specific component. After the action, the policy has been applied, and the domain boundary now exists at that point.

For the purposes of this Recommendation, control domains are analogous to management domains, in that they involve a collection of control plane components and are useful in delimiting ownership or responsibility. Control plane behaviour is managed entirely via the ASON control related services and protocols.

For example, a re-routing domain is formed around a routing area by installing ASON components responsible for restoration at that boundary. Enabling UNI signalling and disabling routing services causes a UNI signalling control domain boundary to be created. See clause 9.1.3 for domain configuration management requirements.

8.4 Transport resources

Figure 8 illustrates the ASON view of transport resources.

Management systems view the network as a set of nodes (subnetworks) and links. While the control plane view of the network is very similar, its nodes are routing areas and its links are SNPP links. This difference is fundamental, and has to do with the fact that the control plane operates in a name space than is different from that used by the management plane. A management system therefore needs to have a view of the resources as they are described in the control plane. This is shown in

Figure 8. There should be no duplication of information already available to the management plane via CTPs. Consequently, a critical part of this fragment is the SNP-CTP association, which allows names in the management space to be navigated to names in the control space. Also note that shared risk groups are accounted for by Group attributes attached to the entities that a shared risk group may affect. Shared risk group attributes may propagate up from the trail to the SNP link connection to the SNPP link.

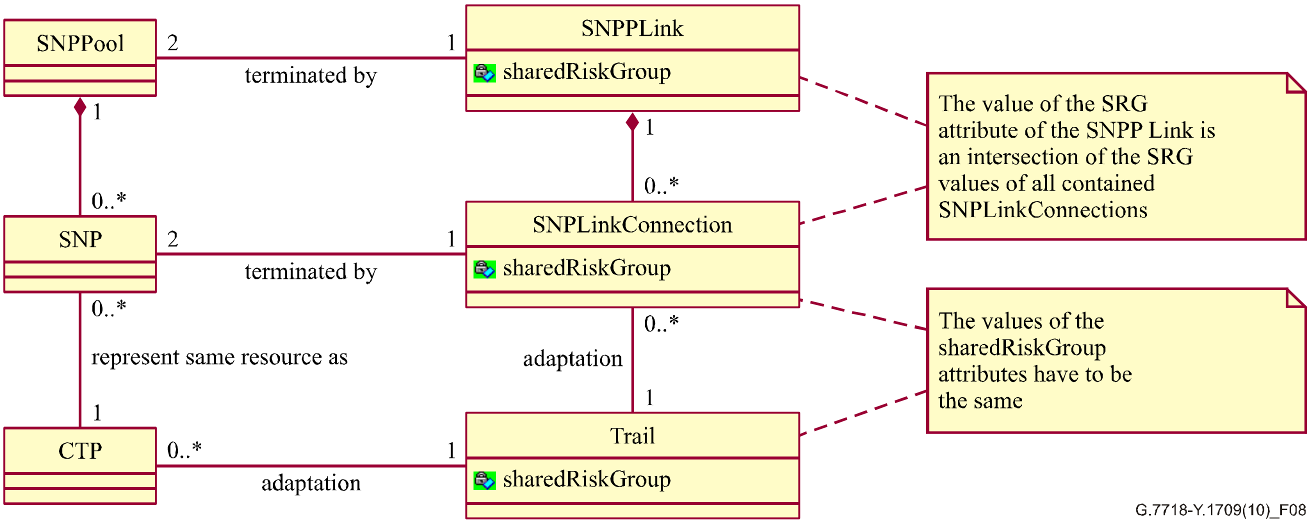


Figure 8 – ASON view of transport resources

8.5 Policies

Policies express the requirement to have a particular behaviour at the edge of a specified domain. Policies result in actions that are visible at the edge of the domain, thus creating a domain boundary. The policy is thus *why* an action is applied. Conversely management systems need to know what the action is in order to apply the policy.

8.6 Management of protection and restoration

Connections in an ASON control domain can be protected or unprotected. Individual connections through an ASON domain could belong to a protected network connection where the protection end-points are outside of a particular ASON domain. In this case, the ASON connections must fulfil certain routing constraints within a particular domain, i.e., the two connections must be mutually diverse within the ASON domain and are thus not fully independent.

In general, when SPCs are set up, it is the management system that provides the class of service parameters which determine whether the SPCs are protected or not. Once a protected SPC has been established, the management system is informed that the requisite class of service parameters are met and can query the CP for protection state information. If an SPC is for example 1+1 SNCP protected, the management system can determine which of the two protection legs is currently selected by querying the CP. Additionally, an operator may manually select one of the two legs or even force the selection in case some maintenance actions need to be carried out in the network. It is possible to change the class of service parameters of an already established SPC which may in turn lead to a modification of the SPC's protection type.

The ASON network may have the capability to automatically restore connections within a re-routing domain when a failure has occurred. Different restoration mechanisms may be provided by the ASON network including, for example, connections with or without pre-calculated backup paths. In the latter case, a backup path is only calculated and activated after the occurrence of a failure and an affected connection is restored on a best effort basis. When the management plane establishes SPCs, the class of service parameters also determine the restoration mechanism that is applied.

In the context of restoration, it is important to know whether, and how, reversion is done when the failure in the network has cleared. The selection of restoration and reversion mechanisms depends on individual operator policy. Examples of such policies are that the ASON network does not revert restored connections, carries out reversion automatically without requiring any operator intervention or only performs reversion once the operator has confirmed the execution of the reversion process ('manual reversion'). A deeper involvement of the management plane is required in the case of manual reversion where the management plane needs to keep track of the restoration state (e.g., connection is on the nominal route, connection is currently restored and thus on a backup, connection is ready for reversion).

8.7 Security management

Security management is for further study.

8.8 Management of the data communication network

[ITU-T G.7712] contains the specifications for the data communications network (DCN) used to support management plane communications and ASON control plane communications. The management aspects of the DCN itself are not impacted by the presence of a control plane.

8.9 Accounting management

This Recommendation is limited to the representation, storage and communication of data associated with ASON call details.

9 ASON management requirements

The following four requirements are the fundamental requirements for ASON management.

R 1 A failure in the MP shall not affect the normal operation of a configured and operational CP or transport plane.

R 2 A failure in the CP-MP interface shall not affect configured services in the transport plane.

NOTE – Requirement R 2 is derived from [ITU-T G.8080] principle that states that existing connections in the transport plane are not altered if the control plane fails and/or recovers.

R 3 The MP shall not be affected (impacted) by a failure in the CP.

R 3.1 The failure and recovery of the CP-MP interface shall be detected by the MP.

9.1 Configuration management

As previously noted, there is no assumption that any ASON component is anchored to a network element. This is especially important in the case of call controllers.

The initial configuration of a network element includes specification of the appropriate CP functions and parameters. This includes configuration of the requisite ASON component parameters including their identifiers and addresses, signalling and routing protocol parameters (defined in [ITU-T G.7713], [ITU-T G.7713.1], [ITU-T G.7713.2], [ITU-T G.7713.3], [ITU-T G.7715], and [ITU-T G.7715.1], and CP communications network information. The configuration must be performed prior to invoking CP functions in the network.

9.1.1 Identifier management

It is assumed that all network elements have been assigned an identifier in the management plane.

R 4 The CP-MP interface shall support the assignment of identifiers for all identifier spaces, e.g., RA identifiers, SNPP identifiers, UNI/E-NNI transport resource identifiers, etc.

R 5 The CP-MP interface shall support the administration of identifiers including insuring their uniqueness within their respective spaces. In the case of protocol controller identifiers, this includes the relationship between the identifier and the point of attachment to the DCN.

R 6 It shall be possible to locate resources in one plane, i.e., the CP or the MP, and to navigate to the same resource from the other plane.

R 7 The MP-CP interface shall support the ability to assign UNI/E-NNI transport resource identifiers per individual carrier's specifications.

R 8 The CP-MP interface shall support the ability to configure the binding, and retrieve the relationship, of a UNI/E-NNI transport resource identifier and the corresponding UNI/E-NNI SNPP identifier.

9.1.2 Resource management

R 9 The CP-MP interface shall support the allocation of transport resources, e.g., CTPs, to the CP. Only one SNP in each SNPP can be associated with a CTP. Multiple SNPs (in different SNPPs) can be associated with a single CTP.

R 10 The CP-MP interface shall support the allocation of flexible adaptation resources to the CP.

R 11 The CP-MP interface shall support the configuration of a specific SNP. The information to be configured for the SNPP members is:

a) SNP/CTP relationship

NOTE 1 – The lower order part of the SNP identifier may either be provided or auto-generated from the lower order part of the CTP name (i.e., time slot).

b) SNP parameters (SNP states as not validated, shared, etc.).

R 12 The CP-MP interface shall support the capability of assigning all CTP link connections in one trail to one SNPP link in one operation.

R 13 The CP-MP interface shall support the capability of binding SNPs to CTPs without having to manually provision each binding.

R 14 The CP-MP interface shall support the configuration of parameters required for diverse routing.

R 15 The CP-MP interface shall support for each SNPP, the configuration of the CP functions required to create/delete/modify the following interfaces: UNI, I-NNI and E-NNI.

R 16 The CP-MP interface shall support the transfer of routing database information between the MP and the CP.

R 17 The CP-MP interface shall support the ability to either assign or remove resources to/from the control plane. (When the transport resources are not being used to support any existing connections/connection segments, they can be moved from MP control to CP control or vice versa. Other scenarios, including the migration from MP to CP or vice versa, require further study.)

R 18 The CP-MP interface shall permit the MP to shut down specified transport resources.

See also [ITU-T X.731] for the definition of "shutting down" state.

R 19 The CP-MP interface shall support the ability to define one or more shared risk groups (SRG).

R 20 The CP-MP interface shall support the provisioning of a link to belong to multiple SRGs.

R 21 The CP-MP interface shall support the configuration of SNPP links which will include at least the provisioning of routing area information.

R 22 The CP-MP interface shall allow the configuration of the SNPP Link parameters needed for routing, signalling and management (name, directionality, cost, etc.).

R 23 The CP-MP interface shall allow single-ended SNPP link provisioning. Note that for this case, initial provisioning of the subnetwork names and SNPP name must be done at both ends.

R 24 The CP-MP interface shall permit the identity of CTP link connections to be provided to the CP by the MP.

R 25 The CP-MP interface shall support the configuration of the parameters necessary for UNI signalling, I-NNI signalling, and E-NNI signalling. A mechanism for detecting inconsistent settings for these parameters shall be provided.

NOTE 2 – The specific parameters are defined in the relevant standards, including [ITU-T G.7713.1], [ITU-T G.7713.2], and [ITU-T G.7713.3].

R 26 The CP-MP interface shall support the configuration of the parameters necessary for I-NNI routing and E-NNI routing. A mechanism for detecting inconsistent settings for these parameters, e.g., timers, shall be provided.

R 27 The CP-MP interface shall support the configuration of the parameters for individual ASON components. A mechanism for detecting inconsistent settings for the parameters shall be provided.

More detailed requirements for ASON protocol controllers are given in clause 9.1.5.

R 28 The CP-MP interface shall support the determination of a resource's assignment, i.e., assigned to the CP or the MP.

R 29 The CP-MP interface shall support the identification of inconsistencies between databases in the MP and CP.

R 30 The CP-MP interface shall support notifications of inconsistencies between the transport plane and the CP databases.

9.1.3 Domain configuration

Domains are configured via the manipulation of UNI and E-NNI interfaces as specified in R 25 and R 26. Other aspects are for further study.

9.1.4 Routing area configuration

R 31 The CP-MP interface shall support the assignment of CP components to routing areas.

R 32 The CP-MP interface shall support the assignment of routing areas hierarchies.

R 33 The CP-MP interface shall support the assignment of CP components to hierarchical routing levels.

R 34 The CP-MP interface shall support routing area aggregation and disaggregation.

R 35 The CP-MP interface shall support reconfiguration of routing area hierarchies.

R 35.1 The CP-MP interface shall support the RC adjacencies configuration.

9.1.5 Protocol controller configuration

R 36 The CP-MP interface shall support the configuration of all the CP protocol controllers on a per interface or per group of interfaces basis. The specific protocol(s) selected for individual protocol controller shall be specified as follows:

a) UNI signalling protocol;

a.1) UNI discovery protocol;

b) E-NNI signalling protocol;

c) E-NNI routing protocol (if multiple protocols are supported);

d) E-NNI discovery protocol;

e) optionally I-NNI signalling protocol;

f) optionally I-NNI routing protocol;

g) optionally I-NNI discovery protocol.

R 37 The CP-MP interface shall support the assignment of the point of attachment to the DCN for each protocol controller. The MP must support the configuration of the binding of the control plane components (e.g., CC) to the protocol controller. Multiple protocol controllers may share the same point of attachment to the DCN. A network element may have multiple points of attachment to the DCN.

R 38 The CP-MP interface shall support the configuration of each protocol controller. At a minimum, configuration of the following shall be supported:

a) specific protocol for each controller among the protocols supported by a given system (specific protocol aspects are taken from the relevant protocol specifications);

b) version number (if defined);

c) protocol controller address.

9.1.6 ASON inventory

The MP needs to support the CP's resources/neighbour discovery functions. The addition of new network resources, e.g., NE, plug-in module, etc., shall be made known to the MP. In addition, any additional capacity made possible by the new network resource must be known to the MP. It is expected that the automatic discovery mechanisms provided by the control plane will aid in the capacity activation process.

R 39 Network elements supporting automatic discovery shall support a management information base for all discovered resources.

R 40 The CP-MP interface shall support notifications of the addition/removal/upgrade of CP objects.

9.1.7 ASON topology

R 41 The MP view of topology shall be independent of the CP protocol choice.

It should be noted that the format of the topology objects will be defined in Recommendations that address ASON information object specifications.

R 42 For intra-domain topology discovery, the CP-MP interface shall support notifications of the discovery of any changes to the intra-domain topology.

R 43 The CP-MP interface shall support notifications of the discovery of any changes to the inter-domain topology.

R 44 The CP-MP interface shall support the maintenance of hierarchical inter-domain topology information.

R 45 The CP-MP interface shall support the capability to query the CP for topological information.

9.1.8 ASON link capability exchange

Link capability exchange is the procedure whereby link resource managers (LRM) exchange information on services they support.

R 46 The CP-MP interface shall support notification of failures in the link capability exchange procedure. The notification shall indicate the reason for the failure.

R 47 The CP-MP interface shall support notifications of a successful link capability exchange procedure. The notifications shall include service attributes for the UNI-C and UNI-N ports.

9.1.9 ASON calls

R 48 The CP-MP interface shall support the ability to manage calls with zero or more connections. For each call, the CP-MP interface shall support the ability to add, remove, or modify a connection.

R 48.1 The CP-MP interface shall support the ability to refresh the management plane and/or control plane view with changes that have occurred in the control plane as a result of call modification. This includes increasing/decreasing the bandwidth of an existing connection, increasing/decreasing the number of connections associated with the call, or increasing/decreasing the size of an inverse multiplexing group.

R 49 The CP-MP interface shall support the retrieval of call attributes including call name, calling/called UNI/E-NNI transport resource name, COS and GOS. The CP-MP interface shall also support the retrieval of call start and end times, and associated connections.

R 50 The CP-MP interface must support the capability to distinguish an SPC from an SC. This is done via a call attribute that distinguishes the party responsible for end point handling of the call (i.e., whether the calling/called party call controller is at the UNI or the management plane).

R 51 The CP-MP interface shall support notifications from the CP of any defects associated with a call release request.

R 51.1 The CP-MP interface shall support call request success indication. The CP-MP interface shall support call request failure indications with a code identifying the reason for the failure.

9.1.10 ASON connections

Service activation includes the set-up, release, and query of connections across the network, in conformance with [ITU-T G.8080]. [ITU-T G.8080] assumes that during connection set-up, a pair of TAPs cooperates to coordinate any adaptation set-up required by the link connection, to provide link connection transmission status information and to accept link connection state information to ensure that the management plane indications are consistent. Management plane consistency includes ensuring that the alarm state of the link connection is consistent, so that spurious alarms are neither generated nor reported.

It is expected that the MP can determine if a given connection is a permanent connection, an SPC, or an SC.

R 52 The CP-MP interface shall support the capability to specify the explicit resource list for the management plane initiated connection set-up request. The explicit resource list is defined in clause 7.2.3.3 of [ITU-T G.7713].

R 53 The CP-MP interface shall support the ability to initiate CP directed maintenance roll-overs.

R 54 The CP-MP interface shall support indications of a successful connection creation. The notification shall contain sufficient information to permit correlation with other connection segments.

R 55 The CP-MP interface shall support connection request failure indications with a code identifying the reason for the failure.

R 56 The CP-MP interface shall support indications of a successful connection re-route action.

R 57 The CP-MP interface shall support indication of the failure of a connection re-route action with a code identifying the reason for the failure.

R 58 The CP-MP interface shall support the retrieval of the status of all connections and the values of connection attributes.

R 59 The CP-MP interface shall support queries of all relevant attributes of CP controlled protected connections.

R 60 The CP-MP interface shall support the configuration of all relevant functions of CP controlled protected connections.

R 61 The CP-MP interface shall support the selection of the reversion process to be used with re-routed connections, e.g., manual or automatic reversion.

9.1.11 ASON SPC and SC

R 62 The CP-MP interface shall support the ability to manage soft permanent connections, including those that make use of VCAT and LCAS functions. Specifically, the following shall be supported:

a) The ability to invoke the set-up of a soft permanent connection.

b) The ability to invoke the release of a soft permanent connection.

c) The ability to invoke the modify operation of a soft permanent connection.

d) The ability to invoke the re-routing of a soft permanent connection.

e) The ability to query the CP for the status of a soft permanent connection.

f) The ability to query the CP for the connection attributes of a soft permanent connection including route information.

g) The ability to allow the MP to request a VCAT SPC with different service levels (making use of diverse routing of bundles).

h) The ability to allow the MP to modify SPCs which make use of the VCAT and LCAS functions, i.e., to increase or decrease the bandwidth without service interruption.

i) The ability to support the provisioning of class of service parameters, which may be mapped to protection/restoration mechanisms and configurations within the networks.

R 62.1 The CP-MP interface shall support requests for migration from a PC to a SPC. The transport resource supporting the PC should be moved from the scope of the MP to the scope of CP without service disruption. A call with the appropriate parameters (including state information) shall be created such that the CP can manage the call.

R 63 The CP-MP interface shall support the ability to specify an SPC using class of service parameters which may be mapped to constraint-based routing. This may include, but are not limited to link, node and SRG diversity.

R 64 The CP-MP interface shall support requests for switched connections (SC). This support shall include:

a) Notifications of the set-up, release, and modification of SCs.

b) The ability to invoke the release of an SC.

c) The ability to invoke the re-routing of an SC.

d) The ability to query the CP for the status of an SC.

e) The ability to query the CP for the connection attributes of an SC including route information.

f) The ability to support the provisioning of class of service parameters, which may be mapped to protection/restoration mechanisms and configurations within the networks.

R 65 The CP-MP interface shall support the exchange of information pertaining to switched-connections created in the network.

NOTE – [ITU-T G.7713] and the ITU-T G.7713.x-series of Recommendations contain specific information on connection attributes.

9.1.12 ASON policies

This Recommendation is limited to configuring policies used in the CP. Access to policy servers and other aspects of policy architecture is out of scope of this Recommendation.

R 66 The CP-MP interface shall support the configuration of policy parameters.

R 67 The CP-MP interface shall support querying of policy parameters.

9.2 Fault management

The following fault management requirements are needed specifically for the control plane.

R 68 The CP-MP interface shall support the configuration of CP alarm characteristics.

R 69 The CP-MP interface shall support autonomous alarm notification from the CP for each CP fault. Information in the notification shall include the resource in alarm, the time the alarm occurred, the probable cause, and the perceived severity of the alarm.

R 70 The CP-MP interface shall support the ability to query all or a subset of the currently active CP alarms.

R 71 The MP shall administer the CP alarm severity in accordance with the TMN requirements specified in [ITU-T M.3100] and [ITU-T M.3120].

R 72 The CP-MP interface shall support querying of the operational state of CP components.

9.3 Performance management

The performance management of the SDH and OTN transport planes is specified in [ITU-T G.784] and [ITU-T G.874] and is outside the scope of this Recommendation. In this clause, performance management means the performance of ASON components, and performance information provided by ASON objects.

R 73 The CP-MP interface shall support the collection of the necessary current and historic usage data, such as call attempts, call set-up failures including reasons and successes. The data should be available upon the query from the management plane.

R 74 The CP-MP interface shall support queries of the connection attempts, connection set-up failures and successes.

R 75 The CP-MP interface shall support the ability to query current and historic CP performance data.

Specific performance parameters for the CP are for further study. A possible parameter is the number of connection re-routing events per call.

R 76 The CP-MP interface shall support the ability to retrieve SNPP link usage information from the CP.

R 77 The CP-MP interface shall support per UNI and E-NNI an appropriate notification of failed connection set-ups, failed connection re-routes, etc., that exceed a configured threshold.

9.4 Accounting management

R 78 The CP-MP interface shall support the capability of querying CP for a batch of call detail records.

R 78.1 Call details record shall be available after a call terminated.

R 78.2 Call details record shall include attributes such as customer identification, call start time, call end time, bandwidth, grade of service, and call type (i.e., SPC or SC).

9.5 Management/configuration of protection and restoration

R 79 The CP-MP interface shall support notifications of a CP restoration failure.

See also R 62 and R 64 for other requirements.

R 80 The CP-MP interface shall support the provisioning of timers (e.g., revert and restore) per re-routing domain.

10 Identifiers and relationships

The introduction of a control plane to transport networks has created additional identifier spaces. Interactions between these identifier spaces and other transport identifiers spaces must be considered for OAM functions and protocol controller design.

The four broad categories of identifiers are the transport plane identifiers used by control plane, control plane component identifiers, DCN identifiers, and MP identifiers. Each of these categories is described in the following clauses.

10.1 Identifiers

10.1.1 Transport plane identifiers used by control plane

Two subcategories are identified for this identifier space. These are:

– SNPP and SNP identifiers. These identifiers are used by the control plane to identify transport plane resources. SNPP identifiers give a routing context as well as a ([ITU-T G.805]) recursive subnetwork context for SNPs. The SNP address is derived from the SNPP address concatenated with a locally significant SNP index. The [ITU-T G.8080] architecture allows multiple SNPP name spaces to exist for the same resources.

– UNI/E-NNI transport resource identifiers. These identifiers are used to identify transport resources at a UNI/E-NNI reference point (SNPP links do not have to be present at reference points). They represent the resources between the client and network (or between networks), not the transport network endpoints. These identifiers are names that the respective call controllers use to specify destinations in making a call.

10.1.2 Control plane component identifiers

As per [ITU-T G.8080], the control plane consists of a number of functional components associated with connection management and routing. Components may be instantiated differently from each other for a given ASON network. For example, one can have centralized routing with distributed signalling. Separate identifiers are thus needed for:

– routing controllers (RCs);

– network call controllers (NCCs);

– connection controllers (CCs).

Additionally, components have protocol controllers (PCs) that are used for protocol specific communication. These also have identifiers that are separate from the (abstract) components, e.g., RCs.

10.1.3 DCN identifiers

To enable control plane components to communicate with each other, the DCN is used. DCN identifiers are the point of attachment of the DCN to the protocol controller. Several PCs may share a DCN point of attachment and any given NE may have multiple points of attachment.

10.1.4 MP identifiers

These identifiers are used to identify management entities that are located in EMS and NMS. Some of these identifiers are the existing identifier spaces used in EMS and NMS for OAM purposes, such as the identifiers for the ([ITU-T M.3100]) TTP and CTP. Generally, they describe a physical locality that supports maintenance and fault correlation activities. CTP identifiers give a physical context to a ([ITU-T G.805]) connection point (timeslot). TTP identifiers provide a physical context for transport equipment (e.g., circuit pack).

10.2 Relationships

Various relationships exist among various identifier spaces described above, and are illustrated in Figure 9.

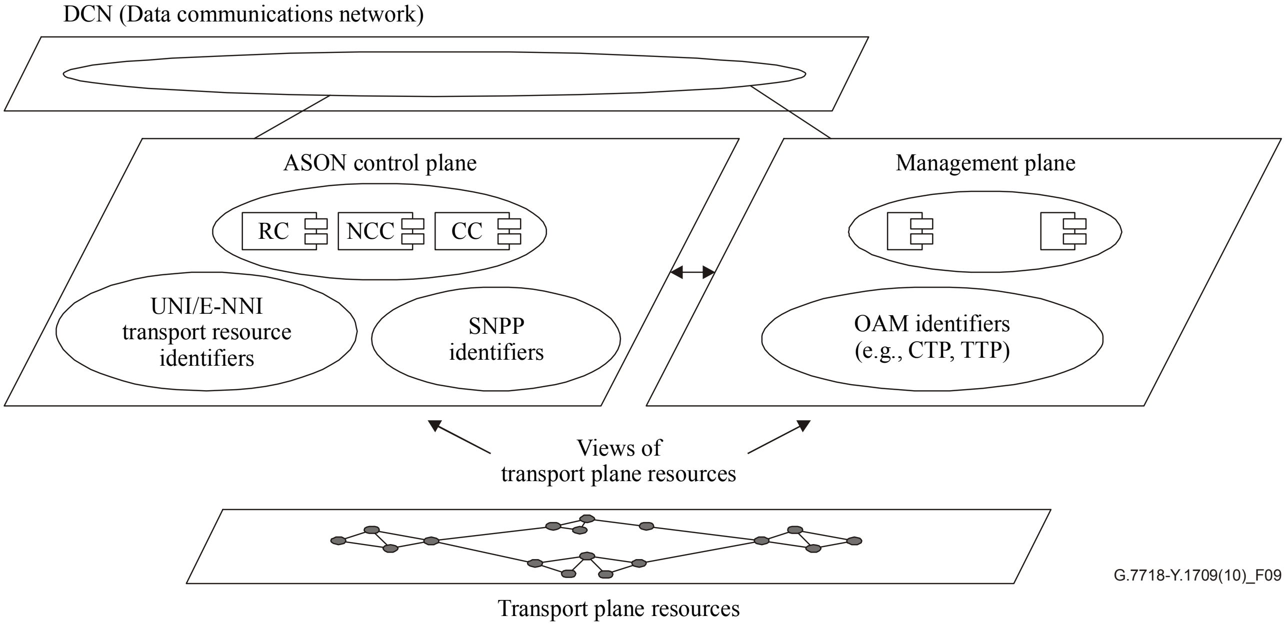


Figure 9 – Identifier space relationships

Appendix I

Example realizations

(This appendix does not form an integral part of this Recommendation)

Figure I.1 shows two control domains separately owned by two carriers. In this case, each control domain is separately managed by the respective carriers' network management systems.

Note that ASON reference points are defined in clause 8 of [ITU-T G.8080].

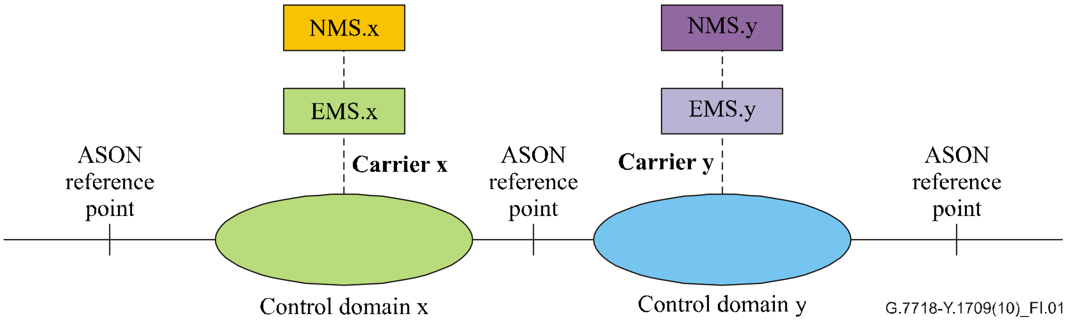


Figure I.1 – Inter-carrier example

Figure I.2 shows an intra-carrier scenario where the carrier's control domains align with the scope of their respective EMSs.

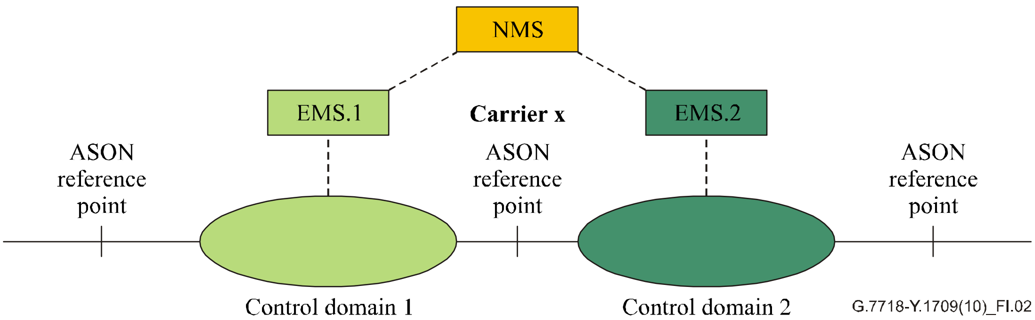


Figure I.2 – Intra-carrier – Control domain and EMS scope aligned

Figure I.3 shows an intra-carrier scenario where the EMS manages multiple control domains.

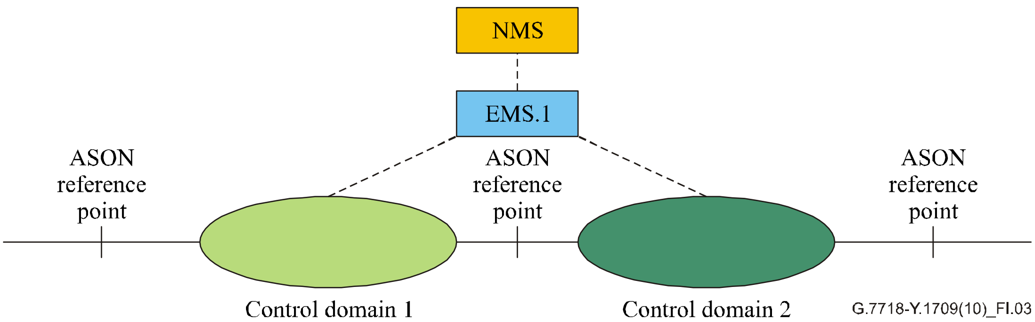


Figure I.3 – Intra-carrier – EMS managing multiple control domains

Figure I.4 shows an intra-carrier scenario where some portion is controlled by traditional management and some via control plane. Depending on the applications (SPCs or SCs) and depending on the role of the traditionally controlled domain, the following configurations are conceivable:

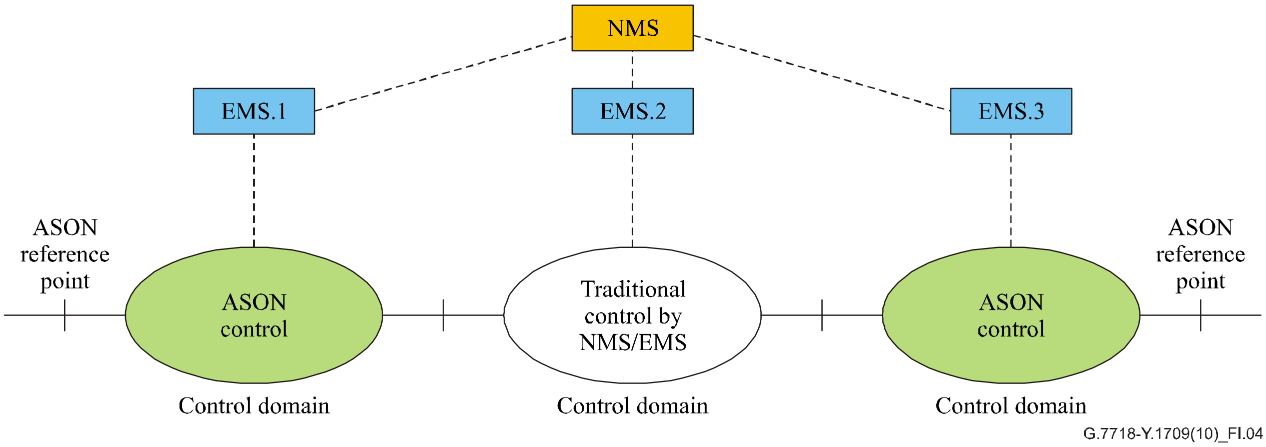


Figure I.4 – Hybrid intra-carrier network

Figure I.5 shows an intra-carrier scenario that only supports SPCs. SPCs begin and end at the boundary of the carrier domain and there is no control plane communication across the links crossing the carrier domain boundary (non-ASON links). Moreover, SPCs are initiated by the NMS and the NMS can establish multiple connection segments independently that form an end-to-end connection across the entire carrier domain. Therefore, the links interconnecting the ASON domains with the traditionally managed domains do not have to participate in the ASON control plane, i.e., support control plane communication. In the ASON control domains, the connection segments are established via the control plane (distributed connection management function), whereas in the traditionally managed domain the NMS has to establish the subnetwork connection (connection segment) in the traditional way via NMS and/or EMS.

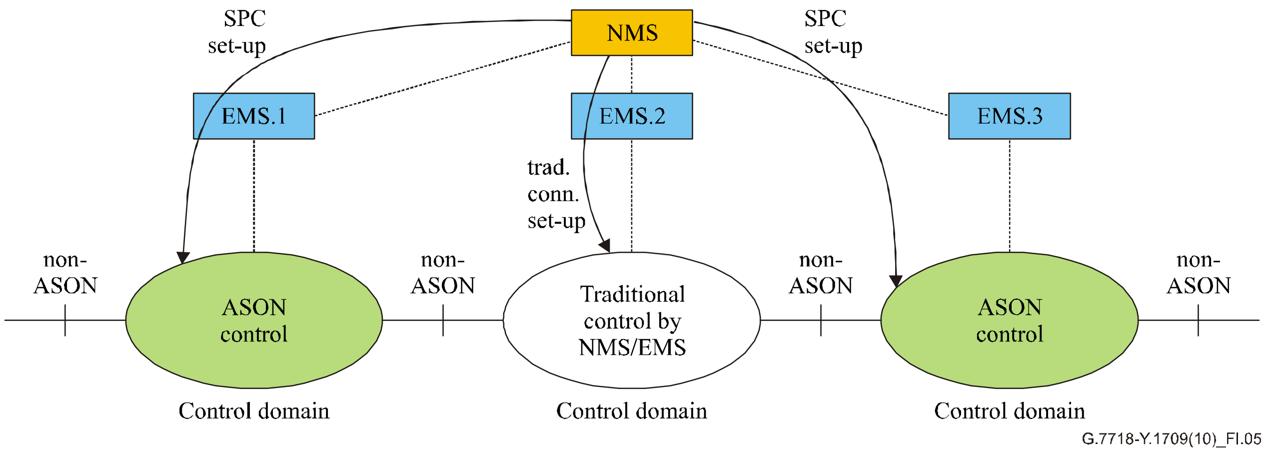


Figure I.5 – Hybrid intra-carrier network for SPCs (simple case)

Figure I.6 shows a hybrid intra-carrier network management scenario for two traditionally managed domains interworking across the ASON domain.

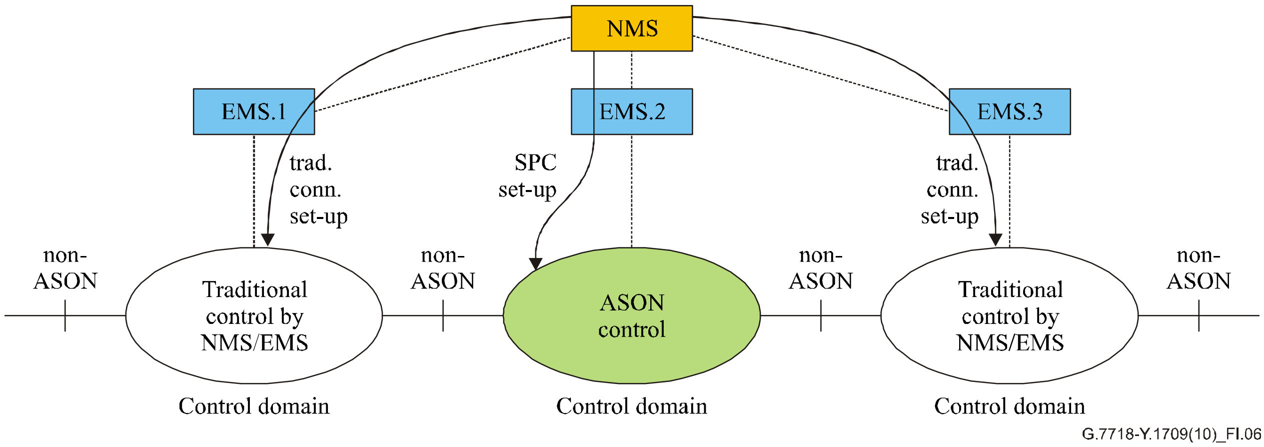


Figure I.6 – Traditional domains interworking across an ASON domain

Figure I.7 shows an intra-carrier scenario that supports both SPCs and SCs across the carrier domain. In this scenario, the links that interconnect an ASON domain with a traditionally managed domain appear as separate E-NNI links. Due to the fact that the traditionally managed domain has no control plane, the signalling and routing information has to be exchanged between the control plane components in the ASON domain and a proxy E-NNI counterpart that is necessary on the non-ASON capable side of the network. The proxies for the different E-NNIs have to interact with the NMS that controls the traditionally managed portion of the network. Here, the traditionally managed domain plays the same role as an ASON domain.

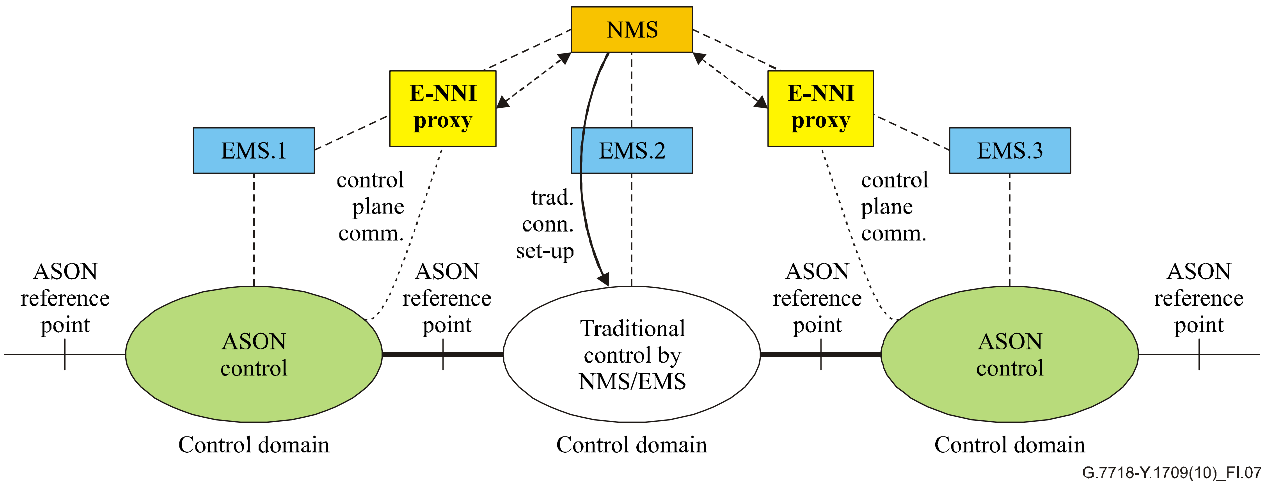


Figure I.7 – Links to a traditional domain as multiple E-NNI links

Figure I.8 shows an intra-carrier scenario that supports both SPCs and SCs across the carrier domain. In this scenario, the links that interconnect an ASON domain with a traditionally managed domain appear as separate E-NNI links. This figure gives an option that one EMS is able to manage both traditional domain and ASON control domain.

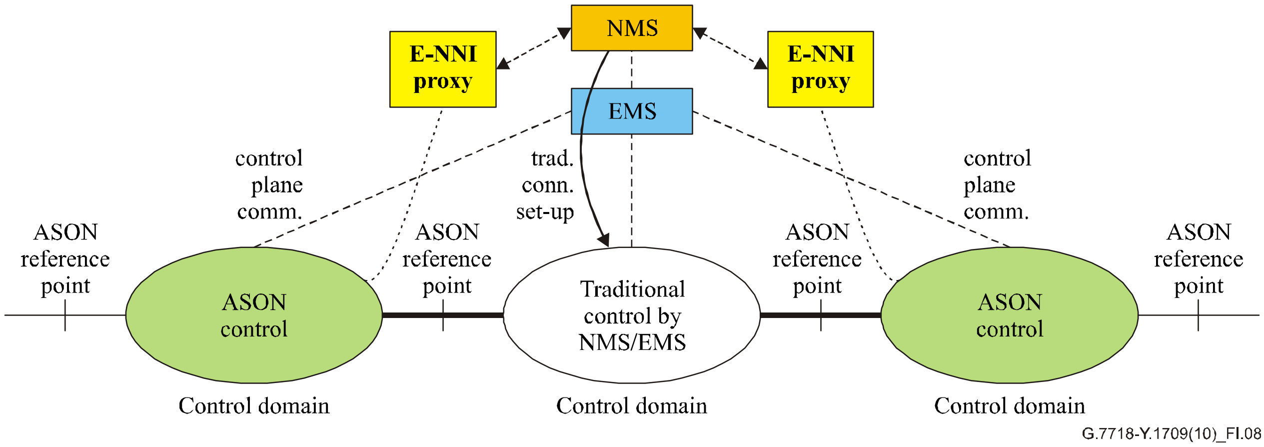


Figure I.8 – Multiple E-NNI links with EMS managed multiple domains

Figure I.9 shows an intra-carrier scenario that is quite similar to the previous one. In this scenario, however, the traditionally managed portion of the networks appears as if the two ASON networks were interconnected directly via an E-NNI. Here, an E-NNI proxy is also required that interacts with the NMS of the traditionally managed domain. But, in contrast to the previous case, the E-NNI proxy could be realized in a much simpler way or can even be omitted in case the subnetwork connections in the traditionally managed portion of the network are statically provisioned. In this case, the internals of the traditionally managed domain become invisible for the ASON domains.

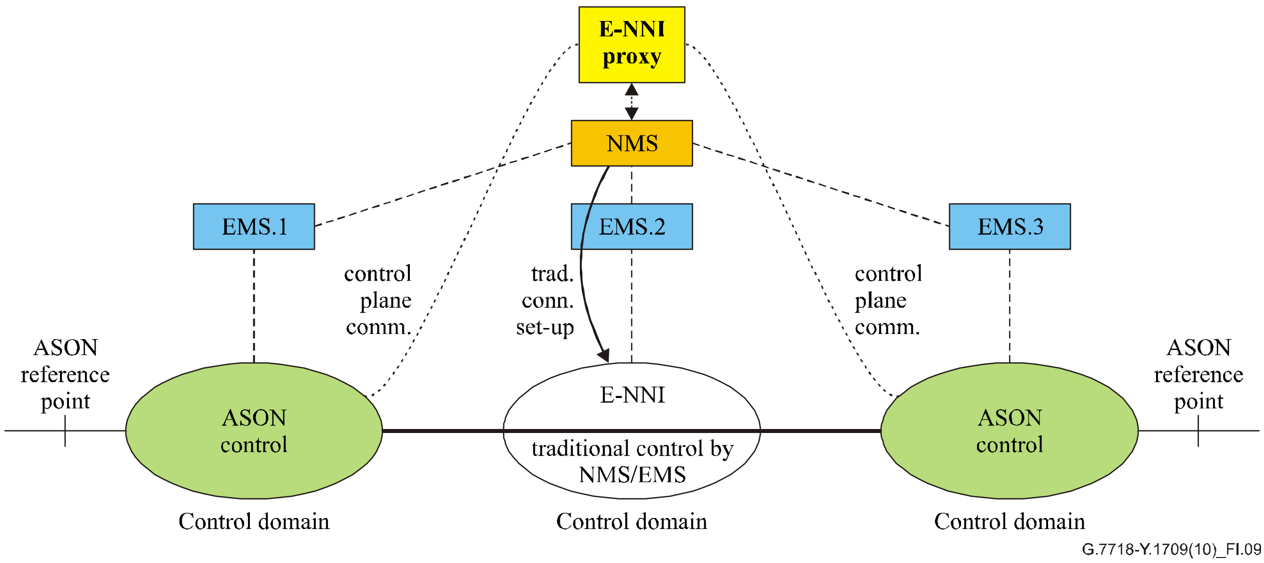


Figure I.9 – Traditional domain with a direct E-NNI link (single proxy)

Appendix II

Management applications

(This appendix does not form an integral part of this Recommendation)

A number of management applications associated with the ASON control plane have been identified. Although these applications are not within the scope of this Recommendation, the following list of applications is provided for guidance for future Management Recommendations.

1) Display a view of the combination of a UNI transport resource address and a logical port identifier in a single screen (so as to uniquely identify a data link).
2) Display, upon request, the soft permanent connection and its attributes.
3) Display the end-to-end path traversed by the soft permanent connection.
4) Determine if a given connection is a permanent connection, an SPC, or an SC. Display permanent connections, SPCs, and SCs in a clear fashion.
5) Correlate cause code information and identify:
   - transport plane network failures;
   - control plane failures;
   - congestion situation;
   - capacity exhaust (in a node, over a link or a link bundle).
6) Correlate two or more subnetwork connections (SNCs) that were created in two or more subnetwork domains (i.e., EMS domain) as a part of a soft permanent connection.
7) Correlate two or more subnetwork connections (SNCs) that were created in two or more subnetwork domains (i.e., EMS domain) as a part of a switched connection.
8) If a control plane component failure occurs, determine what calls and connections are impacted by this failure.
9) Provide report error conditions associated with the control plane.
10) Identify inconsistencies between databases in the CP and TP and databases in the MP and CP, and to restore consistency without affecting active connections.
11) Generate notifications/reports on detection of inconsistencies between MP and CP databases.
12) Support the ability to differentiate between configured links and discovered links.
13) Maintain an awareness of calls created in the network and the connections associated with the calls.
14) Analyse CP configurations for network wide consistency. Special emphasis should be on the consistence of the time out setting of CP timers.

Bibliography

[b-ITU-T G.803] Recommendation ITU-T G.803 (2000), *Architecture of transport networks based on the synchronous digital hierarchy (SDH*).

[b-ITU-T G.872] Recommendation ITU-T G.872 (2001), *Architecture of optical transport networks*, plus Amendment 1 (2003).

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Printed in Switzerland
Geneva, 2010